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FERTILITY AND HATCHABILITY OF FALCON EGGS AFTER INSEMINATION WITH FROZEN PEREGRINE FALCON SEMEN

JOHN E. PARKS AND VICTOR HARDASWICK

A procedure for freezing and post-thaw treatment of semen from the Peregrine Falcon (*Falco peregrinus*) was recently reported by Parks et al. (1986). During the spring of 1986, a project was undertaken to test fertility of Peregrine Falcon semen which had been frozen by this procedure and stored in liquid nitrogen for at least one year.

Four female Prairie Falcons (*F. mexicanus*) imprinted on humans and with histories of laying eggs in captivity were acquired from falconers and captive breeders in the United States. Prairie Falcons were used because of their availability and because of reasonable expectations for good fertility (Hardaswick and Smith 1981). Birds were housed in individual breeding chambers at the Ithaca, New York, facility of the Peregrine Fund, Inc. (see Weaver and Cade 1983 for description). Chambers were modified with low perches and nest ledges to enhance interaction between the birds and individuals working with them and to facilitate subsequent artificial insemination. At the onset of the breeding season, individuals working with imprinted falcons engaged in vocalizations, food transfers and other courtship rituals necessary to induce females to lay. Two female American Kestrels (*F. sparverius*) were housed in 1.82 × 1.22 × 2.44 m (L × W × H) chambers equipped with a food port and nest box. Kestrels were not imprinted on humans so that interaction with a male was considered important to initiate courtship behavior and laying by females. Therefore, male kestrels were maintained in adjacent chambers. A window with vertical barring was placed in the common wall which permitted courtship between the male and female but prohibited copulation.

Straws of frozen semen were thawed in a water bath at 4°C and dialyzed to remove glycerol using a stepwise procedure (Parks et al. 1986). Preparation of semen for artificial insemination required approximately 1.5 hr post-thaw. Single inseminations (80 μl) of semen originally diluted 1:3 (v/v) were made within 4–10 hr after oviposition. Thawed, dialyzed semen was maintained at 0–4°C until the oviduct was everted for insemination. Semen was then transferred to an insemination syringe and deposited in the oviduct (Weaver 1983).

After several eggs had been laid following inseminations with frozen-thawed semen two female Prairie Falcons were inseminated with fresh semen to 1) provide a measure of female fertility with fresh semen, and 2) ensure production of young for a separate project. Fresh semen was obtained from a Peregrine Falcon and a Peregrine Fal-

Table 1. Fertility of falcon eggs after artificial insemination with fresh or frozen-thawed semen.

Female[a]	Clutch[b]	Egg-laying Sequence in Days[c,d] 1 5 10 15 20
P1	1	O_o — O_o — — O_o — O_o — —— ——
	2	$O_●$ — — — $X_●$ — — $X_●$ — $X_●$ — — $X_●$ —
P2	1	O_o — O_o — O_o — O_o — $_●O$ — $O_●$ — $X_●$ — — $X_●$ — — $X_●$ — $X_●$ — —
	1 (cont'd)	$X_●$ — $X_●$ — $X_●$ — — $X_●$ — $X_●$ — — — $X_●$ — $X_●$ — $X_●$
P3	1	O_o — — O_o — O_o — O_o — — O_o — O_o — X_o — — O_o — ——
	2	O_o — — — O_o — O_o — O_o — ——
P4	1	O_o — — X_o — X_o — X_o — X_o — — X_o — ——
	2	O_o — — — O_o — — O_o — ——
K1	1	O_o — X_o — — O_o — O_o — O_o — ——

[a] P1–P4, Prairie Falcons; K1, American Kestrel.
[b] Second clutches began 12 to 14 days after removal of first clutches.
[c] O = infertile egg, X = fertile egg, — = no egg laid.
[d] Open circle = insemination with frozen-thawed semen, closed circle = insemination with fresh semen.

con × Gyrfalcon (*F. rusticolus*) hybrid as previously described. Inseminations with fresh semen were similar to those described for frozen-thawed semen except that volumes of 20–70 μl of untreated and undiluted semen were used.

Female Prairie Falcons were managed according to Burnham et al. (1983) in an effort to maximize egg production. Therefore, eggs were removed sequentially as subsequent eggs were laid. The duration of fertility and schedule of inseminations are presented in Table 1.

Eggs were artificially incubated from day one until female P1 began to demonstrate incubating behavior near the end of her first clutch. From that time, all Prairie Falcon eggs were naturally incubated by one of the female Prairie Falcons for 7–10 days prior to artificial incubation to enhance hatchability (Burnham 1983). Consequently, all fertile Prairie Falcon eggs were incubated under the same conditions. Incubation was carried out in Roll-X incubators (Marsh Farms) at 37.5°C with humidity regulated to achieve 15% weight loss to pip. Kestrel eggs were naturally incubated by the laying female from day one until pip.

After individual female Prairie Falcons had incubated eggs for up to 11 d, all eggs were removed in an effort to recycle females and obtain a second clutch. Second clutches were obtained from all three females from which first clutches were removed (Table 1).

After pipping, eggs were transferred to a hatcher and maintained at 36.5°C with relative humidity between 55 and 60% from pip to hatch. Chicks were left in the hatcher until dry and then transferred to a still air brooder at 36°C. Chicks were fed a diet of whole Coturnix Quail (*Coturnix coturnix*) freshly killed and ground daily. Young birds were fed with the aid of small forceps until capable of eating from a shallow dish.

Of a maximum of 28 eggs potentially fertilized with frozen semen seven were fertile (Table 1). Twenty-four eggs were from four Prairie Falcons and four were from a single American Kestrel. Five of the fertile eggs were from female P4, one from female P3, and one from female K1. The reason for the large difference in fertility between females with frozen semen is not known. Five of the fertile Prairie Falcon eggs developed to pip, hatched unassisted and developed normally to fledging. One of the fertile eggs from the kestrel developed normally to pip and hatched with assistance, but the chick died shortly after hatching.

Sixteen of 17 Prairie Falcon eggs potentially fertilized with fresh Peregrine Falcon semen were fertile, eight developed to pip, seven hatched normally and one hatched with assistance. Based on the 11 d duration of sperm fertility reported in female American Kestrels (Bird and Buckland 1977) it is possible that the first eggs laid by female P2 after insemination with fresh semen could have been fertilized by frozen-thawed sperm. However, this possibility is considered unlikely since the first egg laid following insemination with fresh semen was infertile. Female P1 was not inseminated with fresh semen until the beginning of her second clutch, which was 23 d after the final insemination with frozen-thawed semen.

Fertility of eggs following inseminations with frozen semen was 25% compared to 94% fertility with fresh semen. There was no apparent difference between eggs from fresh vs. frozen semen in time of incubation or survival and development of young. Poor hatchability of fertile eggs obtained using fresh semen appeared to be directly related to use of hybrid falcon semen, although this cannot be stated conclusively for every egg. Death of the Peregrine × kestrel hybrid after hatching probably reflects the viability of that hybrid rather than any effect of frozen semen.

All young produced in this project were placed with

licensed Master falconers at approximately 10 d of age in return for information on their growth and development. Young produced using frozen semen have developed normally.

The level of fertility obtained in this study was low but encouraging. Others have obtained fertility levels of up to 30% with frozen kestrel semen using dimethylacetamide as the cryoprotectant rather than glycerol (Brock et al. 1983; Brock 1986). George Gee (pers. comm.) suggested that 50% fertility can be obtained with frozen kestrel semen when dimethyl sulfoxide was used as the cryoprotectant. We have been unable to maintain post-thaw viability of Peregrine sperm with either of these cryoprotectants. The procedures used in this study demonstrate that use of frozen semen is a realistic option in the captive breeding of large falcons. However, more practical methods for processing peregrine semen and higher fertility are needed before frozen semen will be useful in most captive breeding situations.

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NORTHERN HARRIER (*Circus cyaneus*) PREDATION ON WINTERING WATERFOWL

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Foods of the Northern Harrier (*Circus cyaneus*) include mammals (small and/or immature individuals), birds (mostly passerines), amphibians, reptiles, insects and carrion (Errington and Breckenridge 1936; Randall 1940; Hecht 1951; Weller et al. 1955). Blohm et al. (1980) reported flushing harriers from waterfowl carcasses; however, it is uncertain if these harriers had actually killed or were scavenging.

Schipper et al. (1975) observed Northern Harriers opportunistically preying on sick or wounded waterfowl, and Fitzpatrick (1979) observed a harrier drowning a Common Moorhen (*Gallinula chloropus*). However, few observations of harrier attacks on healthy adult or subadult waterfowl have been documented. Hammond (1948) and Griffiths et al. (1954) described harrier attacks on waterfowl; accounts were based upon single observations. Additionally, in neither account was the physical condition of the prey reported.

Our objective is to report four chronological observations of Northern Harriers attacking wintering waterfowl in Castro, Hale, and Parmer counties, Texas. In three of the four observations the ducks were known to be capable of